

Clean Version of Pending Claims 1-23 and 37-49

1 (Amended). A system for circulating blood in a patient comprising:

a cannula enclosing first and second flow paths, the cannula adapted in length and size to extend through an incision into the vena cava or the right atrium and adapted to provide blood intake at a first location in the vena cava or the right atrium and provide blood output at a second location in the pulmonary artery;

a pump communicating with the first and second flow paths and operating to intake blood through the first flow path at the first location and to output blood through the second flow path at the second location, thereby bypassing blood inflow from the right ventricle and the left ventricle;

wherein the pump and cannula, including the first flow path and the second flow path, having a combined priming volume external of the heart and vena cava, and pulmonary artery of not greater than about 1000 ml.

2 (Amended). A system according to claim 1 or 47 wherein the priming volume is not greater than about 30 ml.

B, 3 (Amended). A system according to claim 1 or 47 wherein the priming volume is not greater than about 10 ml.

4. A system according to claim 1 wherein the length of the cannula is adapted to extend through the tricuspid valve, through the pulmonary valve, and into the pulmonary artery.

5 (Amended). A system according to claim 47 wherein the length of the cannula is adapted to extend through the bicuspid valve, through the aortic valve, and into the aorta.

6 (Amended). A system according to claim 1 or 47 wherein the first and second flow paths comprise concentric lumens within the cannula adapted for insertion through a wall of the heart.

7 (Amended). A system according to claim 1 or 47 wherein the first and second flow paths are linear and adapted for insertion at a first end into a heart chamber or blood vessel and at a second end into a blood vessel.

8. A system according to claim 6 wherein the pump comprises a reverse flow pump.

9. A system according to claim 7 wherein the pump comprises a reverse flow pump.

10. A system according to claim 7 wherein the pump is coupled to the first and second flow paths of the cannula external of the heart.

11. A system according to claim 1 wherein the length of the cannula is adapted to extend through an incision in the vena cava or the right atrium and into the pulmonary artery, and the pump is adapted to convey blood from the vena cava or right atrium through the cannula into the

pulmonary artery.

12 (Amended). A system according to claim 47 wherein the length of the cannula is adapted to extend through an incision in the pulmonary vein and into the aorta, and the pump is adapted to convey blood from the pulmonary vein through the cannula into the aorta.

13 (Amended). A system according to claim 1 further comprising:
a second cannula adapted to extend through an incision in the pulmonary vein or the left atrium and into the aorta, and a second pump adapted to convey blood from the pulmonary vein or left atrium through the second cannula into the aorta.

14 (Amended). A system according to claim 1 or 47 further comprising a controller coupled to the pump for controlling the pump speed.

15. A system according to claim 13 further comprising a controller for the first pump and the second pump for controlling the speed of each pump separately.

16. A system according to claim 14 wherein the controller is adapted to control the pump in response to blood pressure, blood oxygen level, blood carbon dioxide level or blood flow volume.

17. A system according to claim 15 wherein a controller is adapted to control the first pump in response to pulmonic pressure and a controller is adapted to control the second pump in response to aortic pressure.

18 (Amended). A system according to claim 1 or 47 further comprising a cradle adapted for supporting the heart while displaced from its normal position and while the surgery is performed thereon.

19 (Amended). A system for preventing collapse of the right atrium, right ventricle or pulmonary artery and maintaining blood flow there through during beating heart surgery comprising:

a pump and cannula system wherein the cannula is adapted for insertion through the tricuspid valve, through the pulmonary valve and a sufficient length into the pulmonary artery to prevent collapse of the right atrium, right ventricle or pulmonary artery and to maintain partial blood flow there through while the beating heart is lifted or displaced during surgery and wherein the pump and cannula are adapted for intake of blood from the pulmonary vein or the left atrium and output of blood into the pulmonary artery, thereby bypassing blood inflow from the right ventricle and the left ventricle, while the beating heart is displaced during surgery; and

a controller for the pump adapted to control the pump in response to venous or pulmonic blood pressure, oxygen level, CO2 level or flow volume.

20. A system according to claim 19 wherein the pump has a priming volume less than about 1000 ml.

21. A system according to claim 19 wherein the pump comprises a reverse flow pump having an adjacent motor and being adapted for operation adjacent to the heart during surgery.

22. A system according to claim 19 wherein the cannula comprises concentric conduits of different lengths and connected to the pump to provide inflow of blood to the pump through the outside conduit and outflow through the inside conduit.

23. A system for preventing collapse of the right atrium, right ventricle or pulmonary artery and maintaining blood flow across the pulmonary valve during beating heart surgery comprising:

a cannula adapted for insertion through the tricuspid valve, through the pulmonary valve and a sufficient length into the pulmonary artery to prevent collapse of the right atrium, right ventricle or pulmonary artery while the beating heart is lifted or displaced during surgery; and

a pump system adapted for removing blood from the vena cava or the right atrium and transporting the blood external of the heart into the pulmonary artery.

37 (Amended). A kit of parts for beating heart surgery comprising:

a cannula system wherein the cannula is adapted for insertion through the tricuspid valve, through the pulmonary valve and a sufficient length into the pulmonary artery to prevent collapse of the right atrium, right ventricle or pulmonary artery and to maintain partial blood flow there through while the beating heart is lifted or displaced during surgery and wherein the cannula is adapted for intake of blood from the vena cava or the right atrium and output of blood into the pulmonary artery while the beating heart is displaced during surgery; and

a pump adapted for communication with the cannula and for pumping blood through the cannula from the vena cava or the right atrium to the pulmonary artery.

38. A kit of parts according to claim 37 wherein the cannula is a coaxial cannula wherein the outer cannula is the intake and the inner cannula is the output.

39 (Amended). A kit of parts according to claim 37 further comprising:

a cannula system wherein the cannula is adapted for insertion through the bicuspid valve, through the aortic valve and a sufficient length into the aorta to prevent collapse of the left atrium, left ventricle or aorta and to maintain partial blood flow there through while the beating heart is lifted or displaced during surgery and wherein the cannula is adapted for intake of blood from the pulmonary vein or the left atrium and output of blood into the aorta while the beating heart is displaced during surgery; and

a pump adapted for communication with the cannula and for pumping blood through the cannula from the pulmonary vein or the left atrium to the aorta.

40. A kit of parts according to claim 39 wherein the cannula is a coaxial cannula wherein the outer cannula is the intake and the inner cannula is the output.

41. A kit of parts according to claim 37 further comprising a controller adapted to control the pump in response to blood pressure, oxygen level, carbon dioxide level or flow level.

42. A kit of parts according to claim 39 further comprising a controller adapted to control the pump in response to blood pressure, oxygen level, carbon dioxide level or flow level.

43. A kit of parts for heart surgery comprising:
a cannula system wherein the cannula is adapted at one end for insertion through an incision in the vena cava or right atrium and adapted at the other end through an incision in the pulmonary artery to maintain blood flow there through while the heart is lifted or displaced during surgery and wherein the cannula is adapted for intake of blood from the vena cava or right atrium and output of blood into the pulmonary artery while the heart is displaced during surgery; and
a pump adapted for communication with the cannula and for pumping blood through the cannula from the vena cava or right atrium to the pulmonary artery.

44 (Amended). A kit of parts according to claim 43 further comprising:
a cannula system wherein the cannula is adapted at one end for insertion through an incision in the pulmonary vein or the left atrium and adapted at the other end for insertion through an incision in the aorta to maintain blood flow there through while the heart is lifted or displaced during surgery and wherein the cannula is adapted for intake of blood from the pulmonary vein or left atrium and output of blood into the aorta while the heart is displaced during surgery; and
a pump adapted for communication with the cannula and for pumping blood through the cannula from the pulmonary vein or the left atrium to the aorta.

45. A kit of parts according to claim 43 further comprising a controller adapted to control the pump in response to blood pressure, oxygen level, carbon dioxide level or flow level.

46. A kit of parts according to claim 44 further comprising a controller adapted to control the pump in response to blood pressure, oxygen level, carbon dioxide level or flow level.

47 (New). A system for circulating blood in a patient comprising:
a cannula enclosing first and second flow paths, the cannula adapted in length and size to extend through an incision into the pulmonary vein or the left atrium of the patient's heart and adapted to provide blood intake at a first location in the pulmonary vein or the left atrium and provide blood output at a second location in the aorta;
a pump communicating with the first and second flow paths and operating to intake blood through the first flow path at the first location and to output blood through the second flow path

at the second location, thereby bypassing blood inflow from the right ventricle and the left ventricle;
wherein the pump and cannula, including the first flow path and the second flow path, having a combined priming volume external of the heart, pulmonary vein, and aorta of not greater than about 1000 ml.

48 (New). A system for circulating blood in a patient comprising
an inflow cannula defining a first flow path and having an inflow port sized and configured to be disposed within the vena cava or the right atrium;
an outflow cannula defining a second flow path and having an outflow port sized and configured to be disposed within the pulmonary artery;
an outer cannula enclosing the inflow and outflow cannulas; and
a blood pump communicatively coupled between the inflow and outflow cannulas for transporting blood from the inflow port to the outflow port and thereby bypass blood inflow from the right ventricle and the left ventricle of the patient to transport blood from the vena cava or right atrium to the pulmonary artery,

the system, including the pump and first and second flow paths, having a combined priming volume external of the heart, vena cava, and pulmonary artery of not greater than about 1000 mls.

49 (New). A system for circulating blood in a patient comprising
an inflow cannula defining a first flow path and having an inflow port sized and configured to be disposed within the pulmonary vein or the left atrium of the patient;
an outflow cannula defining a second flow path and having an outflow port sized and configured to be disposed within the aorta;
an outer cannula enclosing the inflow and outflow cannulas; and
a blood pump communicatively coupled between the inflow and outflow cannulas for transporting blood from the inflow port to the outflow port and thereby bypass blood inflow from the right ventricle and the left ventricle of the patient to transport blood from the pulmonary vein or left atrium to the aorta,

the system, including the pump and first and second flow paths, having a combined priming volume external of the heart, pulmonary vein, and aorta of not greater than about 1000 mls.